COPY FOR MR. J. ALLAN ROSS

HYDRO-ELECTRIC INQUIRY COMMISSION

ENGINEERING DATA

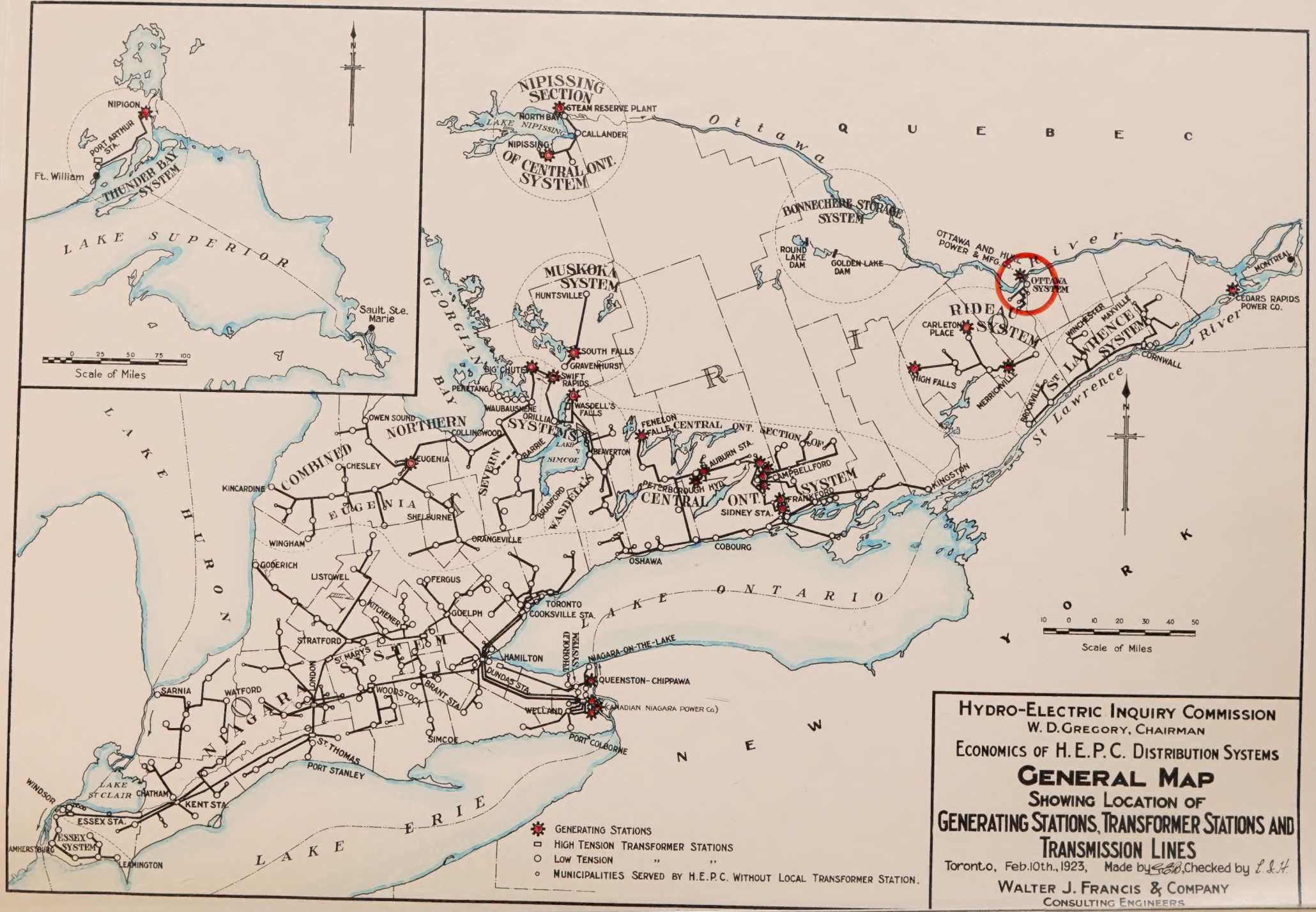
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

STUDY OF OTTAWA SYSTEM

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

OTTAWA SYSTEM


HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
GENERAL MAP
SHOWING LOCATION OF
GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES
Toronto, Feb. 10th., 1923, Made by S.S.B. Checked by L.S.H.
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS
GENERATING STATIONS
HIGH TENSION TRANSFORMER STATIONS
LOW TENSION " "
MUNICIPALITIES SERVED BY H.E.P.C. WITHOUT LOCAL TRANSFORMER STATION.
Scale of Miles
LAKE SUPERIOR
LAKE HURON
LAKE ONTARIO
LAKE ERIE
LAKE ST CLAIR
GEORGIAN BAY
QUEBEC
NEW YORK
Ottawa River
St Lawrence River
NIPISSING SECTION OF CENTRAL ONT. SYSTEM
STEAM RESERVE PLANT
NORTH BAY
CALLANDER
NIPISSING
MUSKOKA SYSTEM
HUNTSVILLE
SOUTH FALLS
GRAVENHURST
BIG CHUTE
SWIFT RAPIDS
PENETANG
WAUBAUSHENE
ORILLIA
WASDELL'S FALLS
BONNECHERE STORAGE SYSTEM
ROUND LAKE DAM
GOLDEN LAKE DAM
OTTAWA AND HULL POWER & MFG. CO.
OTTAWA SYSTEM
RIDEAU SYSTEM
CARLETON PLACE
HIGH FALLS
MERRICKVILLE
BROCKVILLE
ST LAWRENCE SYSTEM
WINCHESTER
MAYVILLE
CORNWALL
CEDARS RAPIDS POWER CO.
MONTREAL
KINGSTON
NORTHERN SYSTEMS
OWEN SOUND
COLLINGWOOD
BARRIE
LAKE SIMCOE
BEAVERTON
FENELON FALLS
CENTRAL ONT. SECTION OF CENTRAL ONT. SYSTEM
AUBURN STA.
PETERBOROUGH HYD.
CAMPBELLFORD
FRANKFORD
SIDNEY STA.
COBOURG
OSHAWA
COMBINED EUGENIA
CHESLEY
EUGENIA
KINCARDINE
SHELBURNE
WINGHAM
GODERICH
LISTOWEL
ORANGEVILLE
SEVERN
BRADFORD
WASDELL'S
FERGUS
KITCHENER
GUELPH
TORONTO
COOKSVILLE STA.
STRATFORD
ST. MARYS
LONDON
HAMILTON
DUNDAS STA.
THOROLD SYSTEM
NIAGARA-ON-THE-LAKE
QUEENSTON-CHIPPAWA
(CANADIAN NIAGARA POWER Co.)
WELLAND
PORT COLBORNE
NIAGARA SYSTEM
SARNIA
WATFORD
WOODSTOCK
BRANT STA.
SIMCOE
ST. THOMAS
PORT STANLEY
WINDSOR
CHATHAM
KENT STA.
ESSEX STA.
ESSEX SYSTEM
AMHERSTBURG
LEAMINGTON
0 25 50 75 100
Scale of Miles
10 0 10 20 30 40 50
Scale of Miles

To face frontispiece.

General Map Showing Location of

Generating Stations, Transformer Stations and Transmission Lines

of the

Hydro-Electric Power Commission of Ontario.

The area outlined in red shows the

Ottawa System.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

(Index)

INDEX TO OTTAWA SYSTEM

INDEX TO OTTAWA SYSTEM

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

(Illts.)

LIST OF ILLUSTRATIONS

OTTAWA SYSTEM

Toronto, Ontario,

April 20th, 1923.

Hydro-Electric Inquiry Commission,
W. D. Gregory, Esq., Chairman,
T O R O N T O, Ontario.

re Studies of Engineering Economics of the
Ottawa System of the
Hydro-Electric Power Commission of Ontario

Mr. Chairman and Gentlemen,-

In accordance with the letter to your Commission under date of November 4th, 1922, and your confirmation of the general instructions under date of November 15th, 1922, a study has been made of the engineering economics of the Ottawa System of electrical generation and distribution operated by the Hydro-Electric Power Commission of Ontario. The work has been done under the direct personal supervision of Mr. Frederick B. Brown, M. Sc., M.E.I.C., a partner in the firm of Walter J. Francis & Company, in accordance with your instructions.

The subject has been discussed with Mr. Commissioner R. A. Ross in detail, and, generally, with Mr. Bower, the Secretary of your Commission, and constant communication has been maintained with the officials of the Hydro-Electric Power Commission of Ontario.

The reports of Messrs. Price, Waterhouse & Co. have been used as the basis of the financial figures given herein, and reference has been made to the records of the Hydro-Electric Power Commission of Ontario where it was necessary to do so to prepare the diagrams.

It is understood that it is not within the scope of the instructions to examine into any of the legal aspects of the System nor discuss any of the Acts of the Legislature relating to it.

The necessary technical data has required considerable preparation, as much of it is only available in the operating records of the Hydro-Electric Power Commission of Ontario. The printed reports contain a part, but these have had to be supplemented by interviews with various officials, and by searching the voluminous records both at the head office in Toronto and elsewhere.

The general plan under which the report of the studies is presented may be outlined as follows:

(1) A short review of the history and evolution of the System.

(2) A brief physical description of the System.

(3) A brief discussion regarding the characteristics of the market.

(4) A discussion of progressive capital costs.

(5) Statistics regarding progressive revenues, with discussion thereon.

(6) Statistics regarding progressive operating costs and fixed charges, with discussion thereon.

(7) Statistics showing progressive and accumulated deficits or surpluses, with discussion thereon.

(8) Analysis of progressive operating records and of unit revenues per horse-power per annum and of unit costs per horse-power per annum.

(9) A brief discussion of the various important points concerning the System.

The report included herewith as pages 4 to 46 inclusive refers in detail to that portion of the activities of the Hydro-Electric Power Commission known as the Ottawa System. Reference has been made to the possible interconnection of this System with other Systems in the future.

Throughout the report diagrams have been included in the order of the text, while the map included as a frontispiece shows the System generally and its geographical relation to all the other Systems operated by the Hydro-Electric Power Commission of Ontario.

OTTAWA SYSTEM

Frederick B. Brown, M. Sc.

Evolution and Development of the System.

City of Ottawa.

The Ottawa System had its inception on July 31st, 1907, when the Hydro-Electric Power Commission contracted with the City of Ottawa to supply the power required for its municipal operations. On the same day, the Commission signed a contract with the Ottawa & Hull Power & Manufacturing Company to purchase sufficient electric power to meet the requirements of the Corporation of the City of Ottawa. Under this contract the Ottawa & Hull Power & Manufacturing Company agreed to sell to the Hydro-Electric Power Commission of Ontario 1,500 electrical horse-power at the flat rate of $15.00 per horse-power year, and to supply additional power at the same rate up to 1,000 horse-power, making a maximum of 2,500 horse-power. The period of the contract was ten years and in it the Company agreed to deliver the power to the Corporation of the City of Ottawa at the city limits at Chaudiere Bridge.

The power requirements of the Municipal Corporation of the City of Ottawa increased very rapidly and soon exceeded the maximum amount available under the contracts mentioned above, and on December 6th, 1910, amendments to both these agreements were signed and made effective, increasing the maximum horse-power available to 4,000 horse-power at the same rate of

Appendix A

Frederick B. Brown, M. Sc.

Problems and Developments of Municipal Systems

City of Winnipeg

The Winnipeg Electric Company has been operating for many years, first, under the Winnipeg Electric Power Generation Agreement with the City of Winnipeg to supply the power required for its municipal operations. In the same way, the Manitoba Hydro is operated with the Winnipeg Power & Manufacturing Co. Ltd. to produce sufficient electric power to meet the requirements of the Corporation of the City of Winnipeg. Until 1921 operating the system I mentioned a Municipally Owned Agency is held by the Public-Utilities Commission of Winnipeg. Its Electrical Department at the time was one of 12 by Inter-Department Law, and is supply electrical power to the main pumping station of Winnipeg, making a saving of 1,000 horse-power. The overall of the contract was 10 years and in it the Commission agreed to initial the power to the Corporation of the City of Winnipeg at the city limits of Winnipeg Prices.

The power requirements of the Municipal Corporation of the City of Winnipeg increased very rapidly, and some matters in relation thereto problems arose the Commission considered advisable, and on December 4th, 1922, consent to work these agreements have signed and have effectively terminated the Winnipeg Power-Generation Agreement in 1927 Corporation of the same type of

$15.00 per horse-power year.

The load of the City of Ottawa continued to increase rapidly. In 1912 about 3,100 horse-power was being purchased, and by the end of 1913 the demand again exceeded the total amount included in the contracts, thus necessitating further provision for power.

An agreement between the Commission and the Ottawa & Hull Power & Manufacturing Company was drawn up on December 8th, 1913, superseding all previous agreements between the two parties and providing for the delivery of from 5,000 horse-power to 20,000 horse-power, at rates ranging from $14.00 per horse-power for the minimum requirements to $11.00 per horse-power when the load on the System will have reached 18,000 horse-power. This agreement is to remain in force for a period of thirteen years, and provides, at the option of the Commission, for its renewal for one or two further terms of ten years, notice to be given to the Company by the Commission of its intention to renew the agreement at least two years before the expiration of the term of years then in force. Excerpts from this document are contained in further detail in Exhibit II of the Price, Waterhouse & Co. report on "Investigation of Accounts of Ottawa System" dated November 7th, 1922.

The Order-in-Council approving this agreement is dated March 4th, 1914, and is as follows:

> "Upon the recommendation of the Hydro-Electric Power Commission of Ontario, the Committee of Council advise that the accompanying contract entered into between the Ottawa & Hull Power & Manufacturing Company and the said Commission, bearing date the eighth day of December, 1913, for the supply of from 5,000 to 18,000 horse-power of electrical power at or near the Corporation of the City of Ottawa, be approved by Your Honour."

On February 2nd, 1914, an agreement between the Commission and the City of Ottawa was drawn up to conform to the revised agreement made during the preceding December with the Ottawa & Hull Power & Manufacturing Company. This agreement with the City of Ottawa, which supersedes all previous agreements, provides for the purchase of power at rates equivalent to those paid by the Commission to the Company, together with operating costs, interest on the capital investment made by the Commission, and payments to the reserve accounts. It is to remain in force for a period of ten years from the date of the first delivery of power under this agreement, and may be continued, at the option of the Corporation of the City of Ottawa, for one or two further consecutive terms of ten years each, all as contained in fuller detail in Exhibit II of the Price, Waterhouse & Co. report previously mentioned.

Towards the end of the fiscal year 1917, the Hydro-Electric Power Commission of Ontario placed an order with the Ottawa & Hull Power & Manufacturing Company for three blocks of 500 horse-power each, in accordance with the terms of the contract of December 8th, 1913, thus bringing the total power taken to 6,500 horse-power. The additional power was required for the new pumping station of the City of Ottawa located at Lemieux Island. This was put into service on November 12th, 1917, and utilises approximately 2,000 electrical horse-power. The commencement of operations of this pumping station brought about the cancellation of the contract of June, 1916, between the City of Ottawa and the Ottawa & Hull Power & Manufacturing Company for the temporary supply of 750 electrical horse-power to the old Queen Street pumping station, the use of which was discontinued.

During August of 1920 the Ottawa & Hull Power & Manufacturing Company put into operation their No. 2 power house, then recently completed, and shut down their No. 1 plant which had been supplying power to the Ottawa System. Plant No. 2 then took up the service without any interruption to the operation of the System. The Commission's new metering equipment, which in 1919 replaced the original instruments in use, was later moved from Plant No. 1 to Plant No. 2 and tested from time to time to insure accurate service.

The demand on the Ottawa System increased steadily, necessitating orders for additional blocks of power from time to time. The load during October, 1921, 9,098 horse-power, is an increase of about 1,500 horse-power over that in 1920. This was in excess of the amount officially ordered from the power company, and steps were at once taken to provide for further increases. In 1922 the peak demand was 11,394 horse-power, and the load early in 1923 was over 12,000 horse-power.

Rural System.

Consequent to applications for electricity made to the Commission, an agreement was entered into with the Municipal Corporation of the Township of Nepean on August 25th, 1921, under provisions of the Power Commission Act, "to provide for the supply of electrical energy or power to individual users". An Order-in-Council dated September 20th, 1921, authorized this contract, excerpts from which are contained in Exhibit III of the Price, Waterhouse & Co. report. The Order-in-Council of September 20th, 1921, also authorized the Commission to construct twelve miles of transmission lines to serve rural

districts.

This was followed by Orders-in-Council under dates of November 29th, 1921, and June 23rd, 1922, granting the authority to further construct 6.61 miles and 6.50 miles of transmission lines, respectively.

The construction of rural lines on the Ottawa System was commenced in September, 1921. The first twelve miles were completed in February, 1922, and certain consumers in the Township of Nepean were then served with electrical energy. Six additional miles of rural lines were completed during October, 1922, all the rural lines serving a total of eighty-five rural consumers at that date. Since then application for electricity has been made by twenty-five other additional customers, and it is stated that the lines to supply these are now under construction.

The rural lines are being served with power from the Ottawa municipal distributing system. The power supplied is being metered by the City of Ottawa which is reimbursed to include the cost of operation, transformation and line losses at an agreed flat rate of $21.00 per horse-power, thus showing operating and transfer costs of $8.00 per horse-power in addition to the wholesale cost of power to the City of Ottawa which is now $13.00 per horse-power. On June 29th, 1922, the Hydro-Electric Power Commission of Ontario authorized payments to the Corporation of the City of Ottawa for all power supplied to the rural lines of the Ottawa System at the above rate of $21.00 per horse-power. This will evidently constitute the basis for charges to be made to the Township of Nepean, and should have added to it interest charges and such reserve rates as may pertain to the distribution of power to these rural districts.

rural districts.

In connection with rural lines it may be well to note that the Ontario Government has a special act known as the Rural Hydro-Electric Distribution Act, 1921, whereby it may provide up to one-half the capital necessary for primary rural lines under certain conditions. Section 4 of the Act reads as follows:

> "Where power is supplied to a rural power district under the provisions of the Power Commission Act and amendments thereto there may be paid to the municipality or commission distributing the power in such rural power district under the recommendation of the Hydro-Electric Power Commission of Ontario, and the order of the Lieutenant-Governor in Council, a sum not exceeding fifty per cent. of the capital cost of constructing and erecting in the rural power zone primary transmission lines and cables required for the delivery of power in such rural power districts."

COPY

Description of the System.

General.

The Ottawa System lies north and east of the Rideau System. It now comprises that territory in the Province of Ontario within a radius of about ten miles from the City of Ottawa and includes within its boundaries part of the County of Carleton. At the present time the rural lines extend to Bell Corner and Merivale to the south and west of the City of Ottawa.

The map included as a frontispiece shows the whole of the transmission systems of the Hydro-Electric Power Commission of Ontario with the location of generating stations, high voltage transformer stations, high voltage transmission lines, and low voltage transformer stations clearly indicated, and shows the various systems in their relation to one another. The tinted portion

of the map indicates the Ottawa System.

The map included as page 11 shows the Ottawa System on a larger scale than the frontispiece and also gives the names of the principal centres concerned. It also shows the Rideau System which is adjacent to the Ottawa System, and the St. Lawrence System to the southeast of it, both of which at some time may be inter-connected with the Ottawa System.

Speaking broadly, the Ottawa System consists of a distributing system supplied by a large privately-owned generating station which serves the City of Ottawa through underground cables, and some rural lines served from the municipal distributing system of the City of Ottawa.

Generating Stations and Other Sources of Power Supply.

(a) Ottawa & Hull Power & Manufacturing Company, Limited.

The entire power supply for the Ottawa System is purchased from the Ottawa & Hull Power & Manufacturing Company which owns two plants on the Ottawa River at Chaudiere Falls known respectively as Plant No. 1 and Plant No. 2. The water supply for both plants is led from an arch dam about 22 feet high equipped with concrete piers and wooden stop-logs. This dam is located on the Ottawa River between Ottawa and Hull and is also utilized by the Ottawa Light, Heat & Power Company, as well as by a number of other industries. Plant No. 1, installed in 1902, is situated on Philemon Island above Bridge Street, Hull, Quebec. The water is led through a short concrete head-race to a power house measuring about 90 feet by 180 feet, which contains the following equipment. The initial installation consisted of

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
RIDEAU, ST. LAWRENCE AND OTTAWA SYSTEMS

MAP SHOWING LOCATION OF GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES

Toronto, April 20th, 1923. Made by S.R.W., Checked by W.J.F.

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

(11)

three Dayton Globe horizontal turbines each of 2,500 horse-power capacity, which are directly connected to three Canadian General Electric 1,500-K. W., 2-phase, 60-cycle, 2,200-volt generators. Six 1,000-kilowatt station transformers step up the energy of these generators to 3 phase, 60 cycles, 11,000 volts. In 1909 there were added two 3,300 horse-power turbines constructed by William Kennedy & Sons, each of which was directly connected to a 2,000-kilowatt, 3-phase, 60-cycle, 11,000-volt generator, made by the Canadian General Electric Company. These units operate at a mean net head of 32 feet. It is understood that the regular operation of this plant was modified soon after the Ottawa & Hull Power & Manufacturing Company completed their new plant, No. 2, and that it has since then been maintained as a stand-by and as an additional source of power during certain periods.

Plant No. 2, put into operation during August of 1920, gets its water from the dam through a concrete head-race 300 feet wide and 430 feet long, and is situated adjacent to Plant No. 1. The power house is of concrete and is about 200 feet long by 200 feet wide, and also utilizes a mean net head of 32 feet.

This plant is designed for an ultimate installation of four 7,500 horse-power turbines. The installed equipment at the present time consists of one J. M. Voith 7,500 horse-power horizontal turbine and one Boving 7,500 horse-power horizontal turbine. These are directly connected to two 6,750-K.V.A., 3-phase, 60-cycle, 2,300-volt generators made by the Canadian General Electric Company. The voltage is raised to 11,000 volts by means of individual Delta-Y banks of transformers directly connected to the generators. The

two present units operate regularly at about 25 per cent. over their normal rating. It is stated that one additional unit of the same size has been ordered and will be put into Plant No. 2 during the autumn of 1923.

The power supply to the Commission is measured by the Company's meters and checked by the Commission's meters installed in the power house of Plant No. 2, and it is then transmitted to the distributing station of the City of Ottawa through underground cables at 11,000 volts. The Ottawa & Hull Power & Manufacturing Company also sells large blocks of power to the Ottawa Light, Heat & Power Company, to the Hull Electric Company, and to a large number of important industries located in the district of the City of Ottawa.

The Ottawa & Hull Power & Manufacturing Company is said to be contemplating the development of 30,000 or 40,000 horse-power in 1923 or 1924 at Bryson, Quebec, on the Ottawa River at Calumet Island.

(b) Undeveloped Power Sites, Ottawa System.

There are numerous undeveloped power sites within easy transmission distance of the Ottawa and the Rideau Systems, that include land and water rights both in the Provinces of Quebec and Ontario or in Quebec alone. The more important of these are listed in the following table which also gives the names of the rivers, the distance from Ottawa, the head, the approximate future horse-power available, as well as the owners, where this information is available. It will be noted in the table that the distances are given in miles in a straight line from Ottawa. The actual transmission distance from the site to Ottawa would be slightly greater in most cases in order to take advantage of

local conditions, and to follow easily patrolled routes, but the actual distances would not be materially greater than those of the table. The table of horse-power is estimated by using the possible future regulated flow of the various rivers named. Under present conditions the power would be somewhat less than the figures of the table, but the horse-power given should be realized by developing a reasonable amount of storage on each of the watersheds.

Table of Large Undeveloped Power Sites - Ottawa District

River	Name of Site	Direct Distance from Ottawa - Miles	Approx. Head - Feet	Future Commercial Capacity with Fully Regulated River Horse-power	Owner and Remarks
Ottawa	Allumette & Paquette Rapids	73	20	34,000	
Ottawa	Calumet (Bryson)	50	56	40,000	Suggested partial development by Ottawa & Hull Power & Manufacturing Co.
Ottawa	Rocher Fendu 1 & 2	54	70	102,000	
Ottawa	Chenaux	40	35	90,000	
Ottawa	Chats Falls	30	50	150,000	H.E.P.C. of Ontario and various interests, including Robertson Estate.
Ottawa	Deschenes & Britannia	5	20	63,000	Partially developed by Hull Electric Company.
Ottawa	Long Sault (Hawkesbury)	53	19	94,000	2,000 H.P. developed by Hawkesbury Lumber Co.
Ottawa	Carillon	65	47	200,000	Under option to Quebec H.E.H.E. Commission.
Gatineau	Chelsea Rapids	4	60	50,000)	Gilmour & Hughson and
Gatineau	Chelsea Falls	5	80	80,000)	Riordon P. & P. Company.
Gatineau	Cascades	14	25	25,000	F. T. Cross.
Gatineau	Paugan Falls	30	120	130,000	Hull Electric Company, plant being designed.

Table of Large Undeveloped Power Sites - Ottawa District (continued)

River	Name of Site	Direct Distance from Ottawa - Miles	Approx. Head - Feet	Future Commercial Capacity with Fully Regulated River Horse-power	Owner and Remarks
Lievre	Rheaume Falls	16	200	50,000)	McLaren interests, 8,500 horse-power developed at Buckingham utilizing 65 feet head.
Lievre	Buckingham	16	100	25,000)	
Lievre	High Falls	38	180	40,000)	
Rouge	Seven Chute, Table Falls and Walker Chute	53	150	20,000	1,500 horse-power partial development at Table Falls.
Rouge	La Cloche and McTavish	65	50	7,000	
Coulonge	Great Falls	68	100	10,000	

These sites aggregating over one million horse-power are all a possible source of power supply for the Provinces of Ontario and Quebec, the most distant being about 75 miles from the City of Ottawa. They will be referred to again in the section entitled "Growth of Market and Ultimate Sources of Power Supply". There is also a large number of smaller powers in the district which are not included in the table.

Miscellaneous Power Plants in the District.

There are several hydro-electric developments of magnitude in the district of the Ottawa System besides the plants of the Ottawa & Hull Power & Manufacturing Company. Most of these are used to supply electrical energy to the various industries which operate them, but the plants of the Ottawa Light, Heat & Power Company and of the Hull Electric Company are for public

utility use.

As the power situation in the district is affected by the keen competition of these plants, a brief description of them is appended.

The main competitor of the Hydro-Electric Power Commission in the district included as the Ottawa System is the Ottawa Light, Heat & Power Company, which owns three hydro-electric plants on the Ottawa River and one auxiliary steam plant, and distributes power in the City of Ottawa and vicinity in competition with the Corporation of the City of Ottawa. The suburban area served by the Company includes Eastview, Britannia, part of Nepean Township, Gloucester Township and Westboro. Some power is also distributed to Hull and a block of power is sold to the Municipality of Gatineau Point and to the Ottawa Electric Railway Company.

Plant No. 1 of the Ottawa Light, Heat & Power Company, Limited, is situated on Head Street, Ottawa. The water is led from the dam at Chaudiere Falls to the power house through an open wooden flume having a cross sectional area of 400 square feet. The first installation of this plant was made in 1901, and an addition was made in 1909. The installation at the present time consists of three Stillwell-Bierce and one Dayton-Globe horizontal turbines, each of 900 horse-power capacity and directly connected to four Westinghouse 700-kilowatt, 2-phase, 60-cycle, 2,200-volt generators. These units utilize a mean net head of 28 feet.

Plant No. 2, was originally the plant of the Standard Electric Company installed in 1891. It was remodelled in 1910, operating at that time with

two units, and in 1914 a third unit was added. An old timber slide channel conveys the water to the power house situated on Amelia Island, below Bridge Street, Ottawa, and makes available a mean net head of 33 feet. The installed capacity at the present time is 5,100 horse-power, made up of three S. Morgan Smith 1,700 horse-power horizontal turbines directly connected to three Westinghouse 1,300-kilowatt, 2-phase, 60-cycle, 2,200-volt generators.

Plant No. 3, located on Montreal Street, Ottawa, is the auxiliary steam plant of the Ottawa Light, Heat & Power Company, installed in 1905. The equipment consists of four 400 horse-power Babcock & Wilcox boilers, and three 800 horse-power boilers of the same make; two steam turbines, one of 2,000 and one of 4,300 horse-power, making a total capacity of 6,300 horse-power; and two Westinghouse 2-phase, 60-cycle, 2,200-volt generators, one of 1,500 kilowatts capacity and the other of 3,200 kilowatts capacity, or a total of 4,700 kilowatts. This station has installed three banks of two transformers each which step up the voltage to 12,000 volts.

Plant No. 4 of the Ottawa Light, Heat & Power Company was installed with one unit in 1899 by the Ottawa Power Company. A second unit was added in 1900, making a total capacity of 4,000 horse-power. It is also located at Chaudiere Falls on the Ottawa River, the power house being on Middle Street just below Bridge Street, Ottawa. Two Samson-Leffel 2,000 horse-power horizontal turbines operating at a mean net head of 29.5 feet are directly connected to two Canadian General Electric 2-phase, 60-cycle, 2,300-volt, 1,875-K.V.A. generators.

The Hull Electric Company of Hull, Quebec, also generates a surplus

supply of electricity in addition to the requirements of its traction utility operating between Ottawa, Hull and Aylmer, and it sells electrical energy to various classes of consumers in the district of Hull and Aylmer.

The two present generating stations of the Hull Electric Company are located on the Quebec side of the Ottawa River at Deschenes Rapids, and operate under 9 feet head. One plant was installed in 1896, and the other about 1900. In the older power house is a set of six William Kennedy & Sons, 60-inch, 175 horse-power turbines operating a line shaft to which are belted two 150-kilowatt, monocyclic, 2,300-volt, A. C. generators, and two 300-kilowatt, 600-volt, D. C. generators. In the other plant are two sets of five and six 61-inch, Trump turbines, crown geared to two line shafts, the shafts being placed at right angles to one another. Each shaft is direct-connected to one 800-kilowatt, 3-phase, 60-cycle, 2,500-volt generator. The total capacity of the plants is 1,900 kilowatts alternating current and 600 kilowatts direct current.

The Hull Electric Company is said to be now seriously considering the early development of the site owned by the Company at Paugan Falls on the Gatineau River about thirty miles from Ottawa for an ultimate capacity of 125,000 horse-power or more.

There is also a small municipally-owned plant which was installed in 1917 on a branch of the Ottawa River in Hull, containing one 1,100 horse-power turbine operating under 19 feet head, and direct-connected to a 750-K.V.A., 2-phase, 60-cycle, 2,200-volt generator. This plant is used for street lighting in Hull.

Transmission Lines.

Up to October 15th, 1922, the Hydro-Electric Power Commission of Ontario had constructed a total of eighteen miles of low voltage transmission lines forming a 4,160-volt network, supplying the rural districts in the Township of Nepean.

There are no high voltage transmission lines in the Ottawa System that are owned by the Commission. The Corporation of the City of Ottawa gets its power supply at 11,000 volts delivered through the high voltage transmission lines of the Ottawa & Hull Power & Manufacturing Company to the Ottawa city limits, at Chaudiere Bridge, from where it is taken to the Ottawa substation at the same voltage by means of underground cables which form part of the city's electrical distributing system.

Transforming and Distributing Stations.

The Commission does not own any transforming substations on the Ottawa System. The City of Ottawa steps down its power for municipal distribution by means of its own transforming equipment, and also steps down the power for transmission to the rural district for which it receives remuneration as already noted at the rate of about $8.00 per horse-power in addition to the price billed to the city for power supply.

Local Distributing Systems.

With the exception of the rural lines already mentioned, the Hydro-Electric Power Commission does not distribute retail power to consumers on the Ottawa System. The Commission acts as a wholesale distributor only, and in the City of Ottawa the electricity is distributed by a local Commission appointed solely

for that purpose. It is understood that the accounting for this city is done in accordance with the standard accounting system of the Hydro-Electric Power Commission and the details are given in the Annual Reports.

Characteristics of Market.

Population Served and Percentage of Consumers to Population.

The district served by the Ottawa System is both urban and rural, nearly all of the load being in the City of Ottawa.

"Municipal Statistics" of the Province of Ontario for 1921, gives a total population of about 146,000 for that portion of Carleton County which is tributary to the Ottawa System. At December 31st, 1921, the total population in the City of Ottawa was 110,708, with 11,532 consumers served by the local municipal commission.

The Ottawa Light, Heat & Power Company serves the rest of the consumers in that city, and is also the sole distributor of power in the town of Eastview and in the district between Britannia and Ottawa. From the total of about 35,000 population for the suburban territory included as the Ottawa System, about 10,000 might be deducted as the population served by the Ottawa Light, Heat & Power Company. During 1922 the Hydro-Electric Power Commission of Ontario had constructed about eighteen miles of rural lines in the Township of Nepean, thus serving a rural population of about 3,000 or 4,000, the number of consumers being about eighty-five at October, 1922, and the remaining tributary population of about 20,000 or 22,000 can only be supplied by a fairly

extensive system of rural lines.

The Corporation of the City of Ottawa was billed with 7,654 horse-power in the fiscal year 1921. In 1922 the total power billed to the System was 9,135.7 horse-power, of which an amount of about 25 horse-power was taken at the end of 1922 by the rural customers in Nepean Township. Judging by the steady increase in the number of consumers taking power from the municipal distributing system in the City of Ottawa each year, it is expected that the increase during 1923 will be about 600 consumers of all classes taking about 1,000 horse-power. This growth can be accounted for by the fact that the Corporation of the City of Ottawa sells power to consumers at a somewhat lower rate than its competitor, the Ottawa Light, Heat & Power Company.

The following table gives in detail the number of consumers at the end of the fiscal year 1921 in the City of Ottawa, the only place served by the Commission. It also gives the approximate horse-power billed in 1921, and the average horse-power per consumer in 1921. The figures are useful for comparison with other systems, although they should be used with caution. No figures for kilowatt-hours consumed are available.

Table of Market Statistics - City of Ottawa

Population	110,708
Number of Consumers	11,532
Percentage of Consumers to Population	10.5
Horse-power Billed in 1921	7,654
Billed Horse-power per Consumer	0.66
Billed Horse-power per Capita	0.06

Growth of Market and Ultimate Sources of Power Supply.

Since the commencement of operations of the Ottawa System in 1907, the growth of the demand of the Ottawa Municipal System has been fairly rapid. It has increased from about 1,200 horse-power in 1907, to an average of about 9,100 horse-power in 1922, with a maximum peak of about 11,400 horse-power during that year. The following table shows the growth of the population of the City of Ottawa, and the number of consumers taking the Commission's power from 1913 to 1921 inclusive:

Table of Population and Number of Consumers - City of Ottawa

Year	Total Number of Consumers	Population
1913	6,736	100,180
1914	7,350	100,180
1915	8,538	101,785
1916	9,207	100,163
1917	10,007	100,300 ±
1918	10,436	100,561
1919	10,393	107,732
1920	10,939	107,732
1921	11,532	110,708

The problem of serving rural customers is difficult, the average number of consumers per mile of transmission line being small. The experience of the Hydro-Electric Power Commission of Ontario up to the present time indicates that only three or four consumers per mile, on the average, are obtainable. At October 31st, 1922, the number of consumers served by the Commission in the rural districts of the Ottawa System averaged 4.7 per mile of line.

Growth of Farmers and Farmers' Associations in Ontario, Canada.

Since the commencement of operations (i.e. the fiscal year 1918), the growth of the Ontario Farmers' Elevator and Grain Association has been fairly rapid. In the instances from about 2,000 members in 1917, it is in excess of 8,000 members in 1921, with a capacity, and at least 8,000 farmers-owner-shareholders that year. The following table shows the growth of the Association at Ottawa, and the number of farmers-owner-shareholders from 1918 to 1921 inclusive:

Table of Membership and Growth of Farmers' Association - City of Ottawa

Year	Number of Members	Premiums
1918	[illegible]	[illegible]
1919	[illegible]	[illegible]
1920	[illegible]	[illegible]
1921	[illegible]	[illegible]
1922	[illegible]	[illegible]
1923	[illegible]	[illegible]
1924	[illegible]	[illegible]
1925	[illegible]	[illegible]
1926	[illegible]	[illegible]
1927	[illegible]	[illegible]

The problem of serving rural customers is difficult, the average number of farmers-owner-shareholders from being small. The commission of the Farmers-Grain Elevator Association at Ottawa is, in the general line, increasing that only there is the problem of the difficulties are lessening. In Eastern Ont., that, the number of farmers-owner-shareholders in the rural districts of the Ottawa System averaged 6.7 per mile of line.

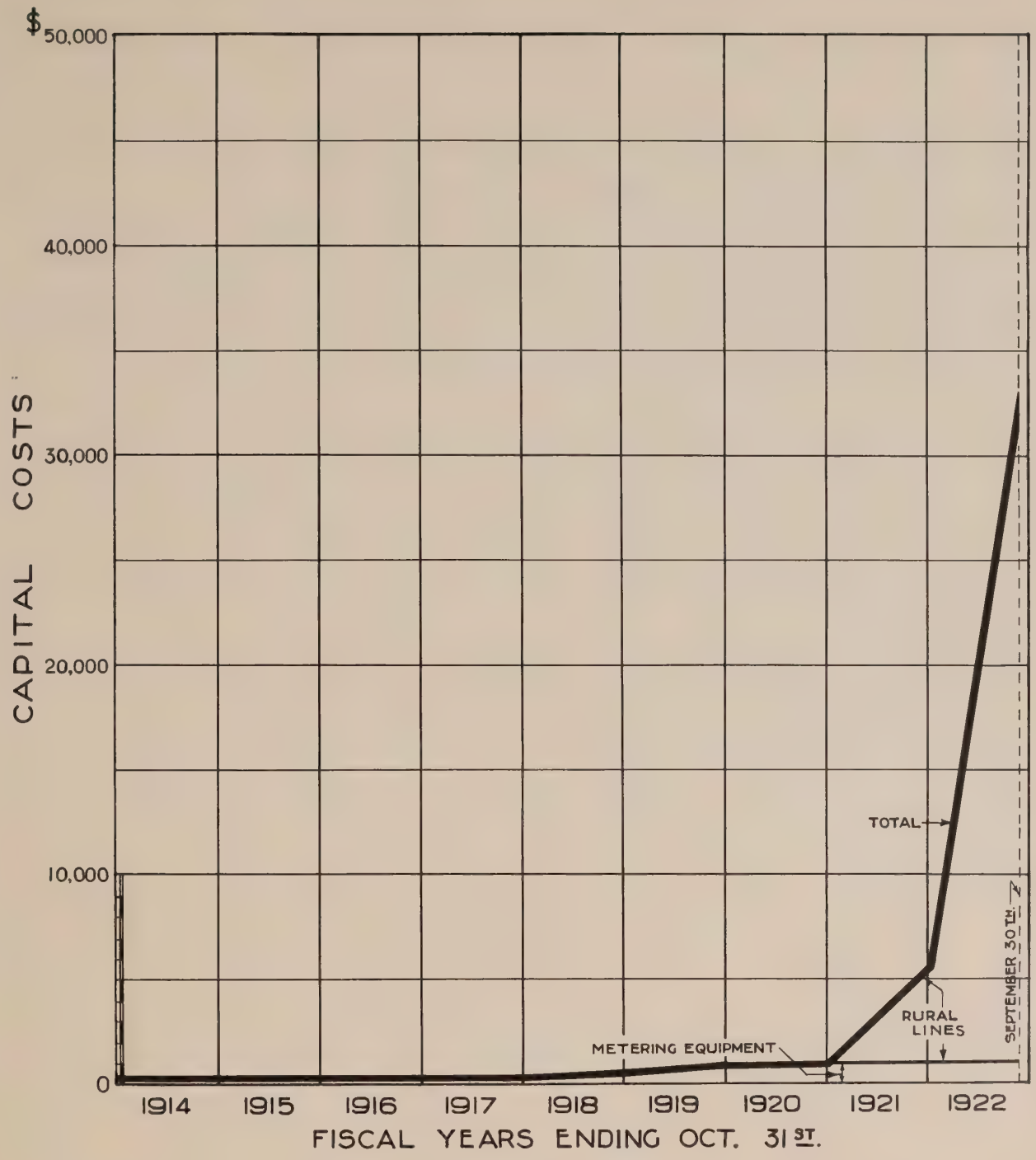
The situation at the present time is that the Ottawa System can purchase an abundant power supply at a very favourable price, thus enabling the City of Ottawa to sell electricity for lighting and other purposes at lower rates than those in most Canadian cities. That the people are satisfied with the service rendered by the municipal distributing system is self evident from the fact that each year since its inception the number of consumers and the demand for power have increased. The domestic power market in the City of Ottawa at the present time has been well covered, and unless the city grows rapidly a large increase in the load of the Commission can only take place by further accretions of consumers from the privately-owned company and by the increased use of current per capita. Both of these factors are evidently influencing the growth. On the other hand, the indications are that there is likely to be a large demand for power for pulp and paper developments, for smelting, and for general manufacturing purposes, provided large blocks of power could be made available in the Ottawa district. The development of one or two of the sites previously mentioned, which it is anticipated will be carried out in the very near future, will provide ample capacity to supply the demands for electricity of the Ottawa System and district for a long time to come. If the Ottawa and Rideau Systems be extended southwards and eastwards and the St. Lawrence System be extended northwards, it is possible that in the future inter-connecting lines may be constructed so that any of these Systems might receive power from the water powers of the Ottawa and Gatineau Rivers, or from the water powers of the St. Lawrence River if these be developed. Because of the networks of high voltage transmission lines now

in existence, the Commission could purchase large blocks of power under wholesale conditions from the privately-owned plants mentioned above, and should be enabled to successfully compete with other distributors of power in the districts of these Systems. It would appear feasible that agreements could be made with large private producers of power to prevent duplication of transmission lines in the districts served by the Commission and thus permit the Hydro-Electric Power Commission of Ontario to serve the whole of the eastern portion of Ontario without competition.

Capital Costs.

General.

The capital costs of the Ottawa System have been almost negligible until the construction of rural lines was commenced. Up to the end of the fiscal year 1920, certain meters located in the Ottawa & Hull Power & Manufacturing Company's plant were the only equipment owned by the Commission. The figures of capital costs given in the following table and plotted diagrammatically on the sheet of curves included as page 25 were obtained from the Annual Reports of the Hydro-Electric Power Commission, and conform with the figures given on page 7 of the "Report on Investigation of Accounts of Ottawa System" by Messrs. Price, Waterhouse & Co.



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
OTTAWA SYSTEM

PROGRESSIVE CAPITAL COSTS

Toronto, April 20th., 1923. Made by [illegible], Checked by [illegible]
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Table of Progressive Capital Costs

	Fiscal Years Ending October 31st,							
	1913 to 1915	1916	1917	1918	1919	1920	1921	1922
Metering Equipment	$432	$432	$432	$591	$1,009	$1,009	$1,009	$ 1,009
Rural Lines	-	-	-	-	-	-	4,698	*32,053
Totals	$432	$432	$432	$591	$1,009	$1,009	$5,707	$33,062

* To September 30th only.

It has been estimated that total funds of $60,000 would be required during 1922 to complete the rural work undertaken and to extend further the rural transmission lines in Nepean Township, and that $30,000 would be required for construction of additional rural lines on the System during 1923. It should be kept in mind that 50 per cent. of the cost of the primary rural lines may be borne by the Province, although to the end of 1922 the total cost has been entered in the books of the Commission.

Power Data.

The following table and the sheet of curves on page 27 have been prepared to show the characteristics of the Ottawa System in terms of horse-power. The figures are as follows:

Table of Horse-power Data

	Fiscal Years Ending October 31st,				
	1918	1919	1920	1921	1922
Purchased and Billed	5,829	6,158	6,764	7,654	9,135.7
Average of 12 Monthly Peaks	5,798.2	6,057.3	6,798.6	7,546.2	9,001.6
Maximum Yearly Peak	6,446	7,038	7,648	9,098	11,394

Table of Progressive Capital Costs

	Fiscal Years Ending October 31st.						
	1916	1917	1918	1919	1920	1921	1922
	In $000						
Metering Equipment	$422	$422	$421	$1,009	$1,009	$1,009	$ 1,009
Rural Lines	-	-	-	-	-	$ [illegible]	$ [illegible]
Totals	[illegible]	[illegible]	[illegible]	$1,009	$1,009	$2,707	$2,[illegible]

* To December 31st only.

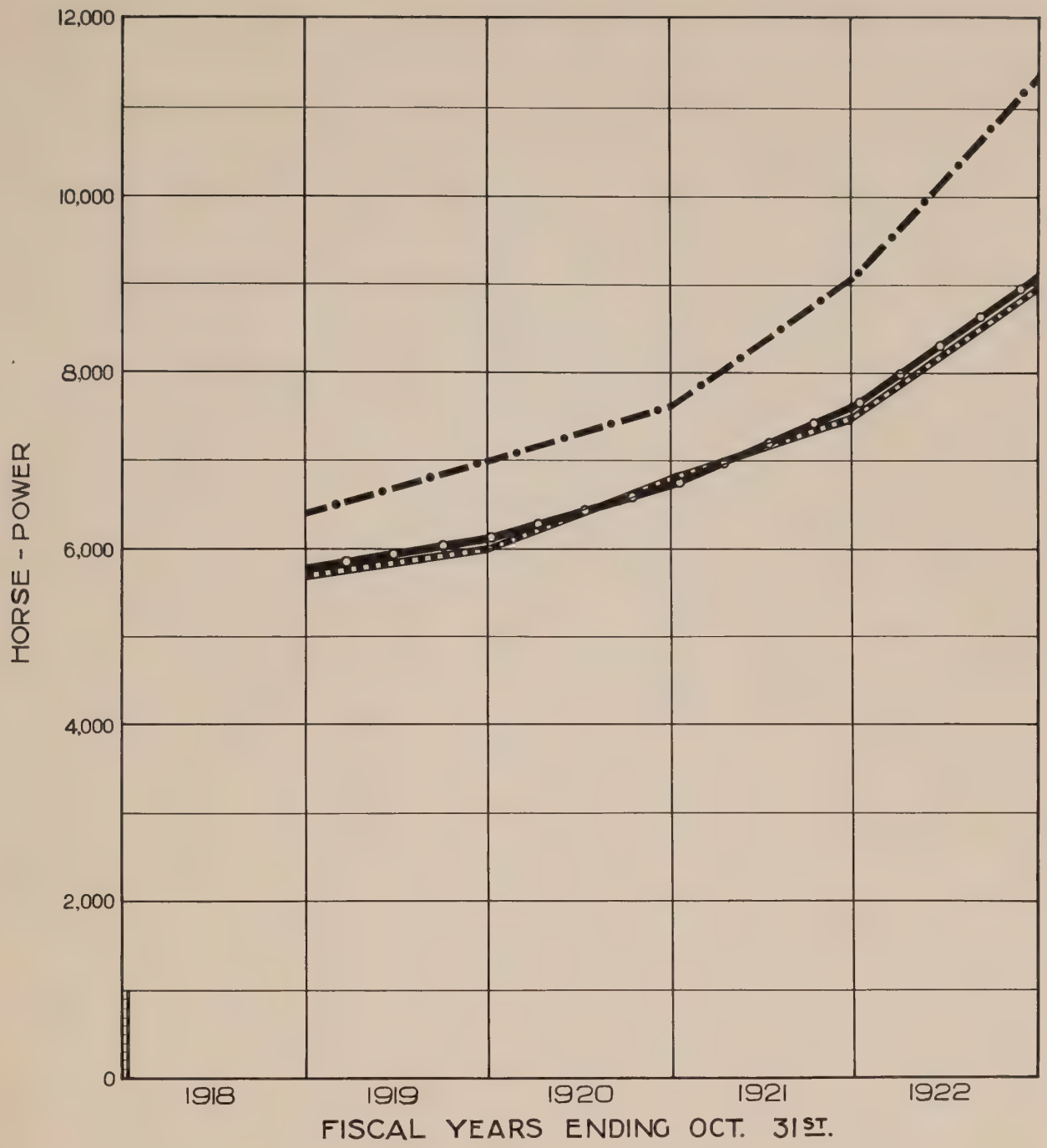
If our Good authority that Equal Sum of $2,000,000 would be required during 1922 to complete the rural work begun in second district the rural transmission lines in Ottawa Township, and that $[illegible] would be required for installation of [illegible] lines on the System during 1922. It should be kept in mind that in the case of the rural lines may be borne by the Province, although to the end of 1922 the total cost has been entered in the books of the Commission.

Power Data.

The following table and the chart at Serve as a guide to show the requirements of the Plant System in order to Correspond. The figures are as follows:

Table of Horse-power Data

	Fiscal Years Ending October 31st.				
	1918	1919	1920	1921	1922
Purchased and Billed	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Average of 12 Monthly Totals	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Maximum Monthly Peak	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



H. P. PURCHASED AND BILLED
H. P., AVERAGE OF 12 MONTHLY PEAKS
H. P., MAXIMUM YEARLY PEAKS

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
OTTAWA SYSTEM

HORSE-POWER DATA

Toronto, April 20th, 1923. Made by [illegible] Checked by [illegible]
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

It will be noted that there are four different classes of horse-power shown in the table and on the diagram. These may be explained as follows:

Purchased Horse-power.

The figures for plotting the curve showing purchased horse-power were obtained from the records of the Hydro-Electric Power Commission and represent the amount purchased from the Ottawa & Hull Power & Manufacturing Company in each of the years 1918 to 1922. It is stipulated in the contract with the Power Company that power is to be reserved in blocks of 500 horse-power until 18,000 horse-power has been ordered, the ultimate amount of power purchasable being 20,000 horse-power. The Commission is to pay for a minimum of 75 per cent. of the power ordered when the power taken falls below that amount.

Billed Horse-power.

The curve of billed horse-power coincides with that of purchased horse-power, the Corporation of the City of Ottawa having been billed with the same number of horse-power as was billed to the Commission by the Power Company. These figures agree with the horse-power billed as shown on page 8 of the Price, Waterhouse & Co. report.

Average Monthly Peaks.

The curve of average monthly peaks was obtained by taking the twelve

monthly peaks for each year as shown in the records of the Hydro-Electric Power Commission of Ontario, and dividing the sum of the monthly peaks by twelve to get a yearly average monthly peak. Each of these averages was then plotted as a single point for the average monthly peak of each year. These figures would conform to the horse-power purchased and billed, but for the fact that during the months of July, 1918, June, July and August of 1919, July and August of 1921, and July and August of 1922, the power taken was less than the minimum contracted for. A small discrepancy also appears in the amount of power billed to the System in 1920. As will be seen from the table of horse-power data, the average of the twelve monthly peaks for that year was 35 horse-power more than the amount billed.

Maximum Yearly Peaks.

The curve showing the maximum yearly peaks was plotted directly from the operating records for each year from the same source as used for the derivation of the curve of average monthly peaks.

Capital Costs per Horse-power Purchased.

The following table indicates the fractional capital costs per horse-power purchased, from the years 1918 to 1922 inclusive, based on the figures showing the capital costs of the System and the horse-power data given above.

Table of Capital Costs per Horse-power Purchased

	Fiscal Years Ending October 31st,				
	1918	1919	1920	1921	1922
Metering Equipment	$0.10	$0.16	$0.15	$0.13	$0.11
Rural Lines	-	-	-	.61	3.51
Totals	$0.10	$0.16	$0.15	$0.74	$3.62

It will be noted that the table of capital costs per horse-power has nothing for generating stations, nothing for high voltage transmission lines, and nothing for distributing stations, as there are none of these on the System.

COPY

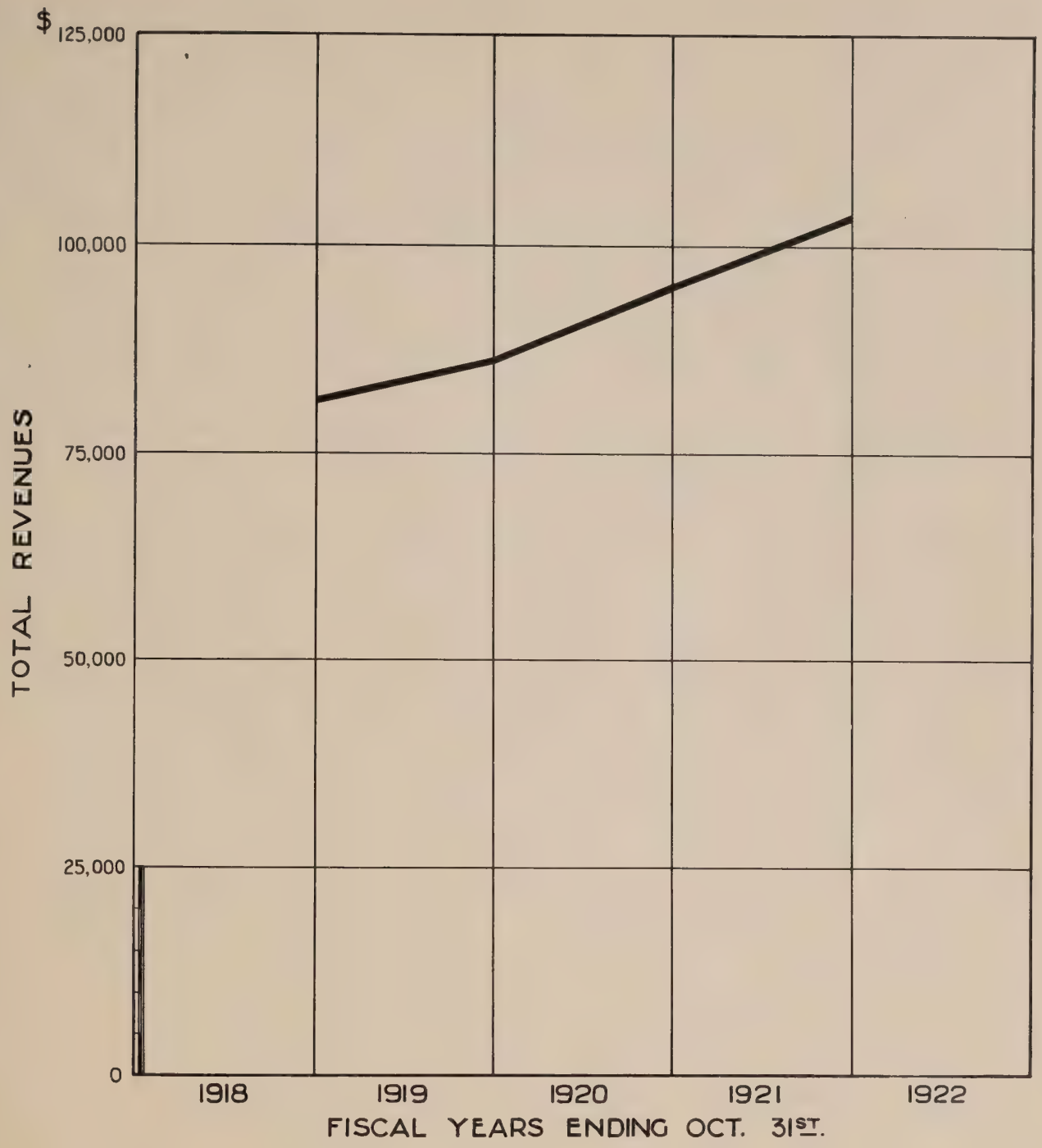
Total Annual Revenues.

The following table and the sheet of curves included as page 31 give the total revenues of the Ottawa System, and have been prepared by using the figures given in Exhibit IV of the report of Messrs. Price, Waterhouse & Co. already mentioned, for the years 1918 to 1921 inclusive.

The City of Ottawa was charged with the cost of power together with operating expenses and that portion of the fixed charges which pertained to the power supply.

Table of Total Annual Revenues

Period Ending October 31st	Total Revenues per Annum
1918	$ 82,276
1919	86,844
1920	95,622
1921	104,088



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
OTTAWA SYSTEM

TOTAL ANNUAL REVENUES

Toronto, April 20th., 1923. Made by [illegible], Checked by [illegible]
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Total Annual Costs of Power.

The table on page 34 shows the cost of power subdivided under various headings for the years 1918 to 1921 inclusive, while the sheet of curves included as page 33 shows these figures plotted in graphic form.

The headings under which the various costs have been grouped are as follows:

Power Purchased.

A separate heading for power purchased has been included for the reason that there is no power generated on this System by the Commission, and the cost of the power purchased comprises practically all the annual costs of power. The figure shown for each year is the total amount of the charges for power purchased from the Ottawa & Hull Power & Manufacturing Company.

Overhead and General Expense.

Under the heading of overhead and general expense are included such items as salaries of executives, printing and stationery, legal expense and so forth, all in accordance with the item headed "Operating Expenses", contained in Exhibit IV of the Price, Waterhouse & Co. report.

Interest and Sinking Fund.

The figures for interest include all interest charges shown for the

(2)

Total Annual Costs at Power.

The table on page 4 shows the (20) 12 years' maintenance costs relating to the power line in each community, with the above at mining plants as shown in above figures (letter to Arnold Ross).

The analysis under which the statement every fair load present are as follows:

Power Transformers.

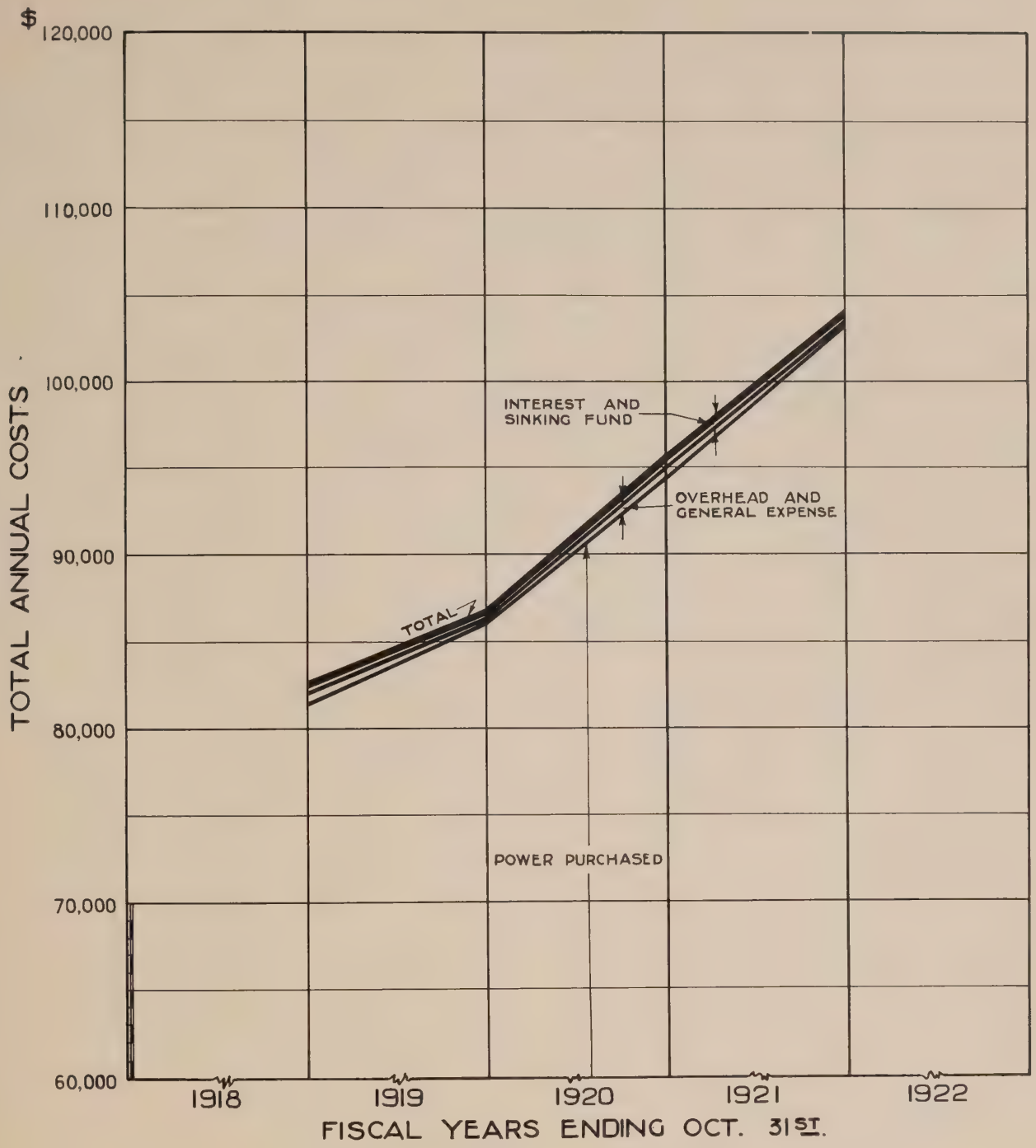
A separate Smelting the power purchased has been included for the reason that there is no power purchased only power by the consultant, and the cost of the power purchase supplies practically all the annual costs of power. The figure shows the main year in the total number of the charges for power purchased from the Ottawa & Hull Power & Manufacturing Company.

Operation and General Charges.

Under the heading of operation and general expenses are included some items of minor of necessity; charging the maintenance, local expenses and so forth, all in accordance with the line based "operating expenses", contained in Exhibit IV of the Price, Waterhouse & Co. report.

Interest and Sinking Fund.

The figures for interest include all interest charges shown for the



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS
OTTAWA SYSTEM

TOTAL ANNUAL COSTS

Toronto, April 20th, 1923. Made by [illegible] Checked by [illegible]
WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

capital invested in the System. The figures for sinking fund have been transferred directly from the report.

The figures for the various items are as follows:

Table of Total Annual Costs of Power

	Fiscal Years Ending October 31st, 1918	1919	1920	1921
Power Purchased	$81,611	$86,218	$94,700	$103,329
Overhead & General Expense	627	572	854	690
Interest	28	40	50	51
Sinking Fund	10	14	18	18
Totals	$82,276	$86,844	$95,622	$104,088

Owing to the fact that the power purchased was delivered directly to the consumer on the System, the Corporation of the City of Ottawa, there have been no expenditures chargeable against operation costs. There being very little property on the System that is owned by the Commission there was also no expenditure for maintenance. These items have, therefore, not been included in the table of total annual costs of power. The items of renewals and contingencies which are also not contained in the table above will be discussed later.

Percentage Costs of Power.

The following table and the sheet of curves included as page 35 show the annual cost figures as percentages of the total cost of power per annum,

capital invested in the system. The figures for existing fuel have been secured directly from the report.

The figures for the various items are as follows:

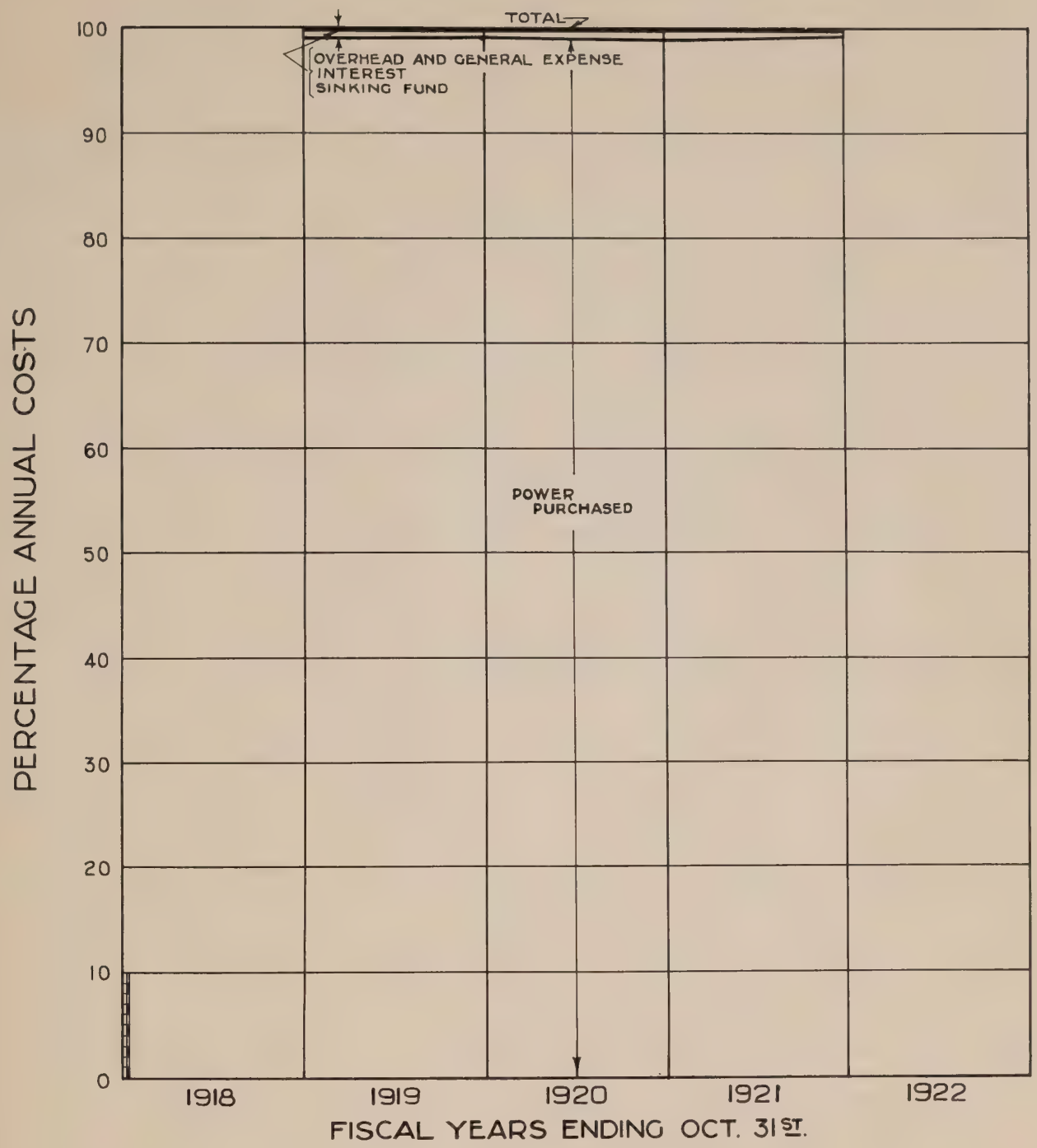
Table of Total Annual Costs of Power

	Fuel Costs Using Coarse Size.			
	1918	1919	1920	1921
Power Purchased	$63,411	$84,114	$94,470	$107,007
Depreciation & General Expense	827	975	885	1,080
Interest	28	40	50	81
Sinking Fund	10	14	12	16
Totals	$62,276	$84,844	$95,622	$108,088

Owing to the fact that the power generated was delivered directly to the consumer on the lines, the depreciation of the city or others, have been as inconsiderable considerable expense. There being very little priority on the lines that it owed by the Commission there was also no expenditure for maintenance. These items, depreciation, and interest, included in the table of total annual costs of power. The items of generating and distributing which are also considered in the table above will be discussed later.

Percentage Costs of Power.

The following table and the chart of curves included on page 21 show the annual fuel charges as percentages of the total cost of power for coarse



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

OTTAWA SYSTEM

ANNUAL COSTS SUBDIVIDED BY PERCENTAGES

Toronto, April 20th, 1923. Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

and these are included as a method of comparison with other systems or similar properties:

Table of Annual Costs Subdivided by Percentages

	Fiscal Years Ending October 31st,			
	1918	1919	1920	1921
Power Purchased	99.20	99.27	99.05	99.28
Overhead & General Expense	0.76	0.66	0.89	0.66
Interest	0.03	0.06	0.05	0.05
Sinking Fund	0.01	0.01	0.01	0.01
Totals	100.0%	100.0%	100.0%	100.0%

Analysis of Reserve Accounts.

Renewals Account.

There has been no provision made to date for renewals of properties in the Ottawa System, it having been stated that in the opinion of the engineers of the Commission no provision was considered necessary. In future, however, a renewals account will probably be set up for rural lines.

It is understood that it is the practice of the Hydro-Electric Power Commission to spend sufficient money on maintenance account each year so as to keep each and every portion of the System in a condition to operate in accordance with the requirements of economical production, which it is stated is considered to be about seventy-five per cent. as good as its original new condition. This being so, it was considered in this report that a renewals account should be studied in connection with the estimated useful life of

and these are included as a matter of convenience with other gardens or similar improvements.

Table of Annual Cash Expenditure in Some Gardens

	1910	1911	Three Years Ending October 31st, 1912	
Fruit Trees	39.22	19.17	31.00	29.39
Vegetable & Annual Flowers	5.75	5.61	5.00	5.88
Lawns	2.00	3.41	1.00	2.13
Stable Yard	[illegible]	[illegible]	[illegible]	[illegible]
Totals	100.00	100.00	100.00	100.00

Ministry of Agriculture, Ontario.

Horticulturist.

There can then be practically none in Ontario for commercial purposes in the Niagara District, it barely does appear that in the relation of the expenditure of the Commercial or practical man or amateur horticulturist, the formal account will probably be set up for rural lines.

It is maintained that it is the practice of the Experimental Stations to which fruit-growers resort to discussions against such practice as they such and other varieties of the Grape in a quantities is inconsistent with the requirements of commercial production. While it is plainly to maintained by the Agricultural College Bulletin, as good as the original the conditions. This being so, if the conditions in this county that a commercial amount should be planted in connection with the additional annual life of

meters and rural transmission lines, and applied to the renewal of only twenty-five per cent. of the capital concerned.

A question that should receive consideration in determining these reserves for renewals is the proper rate of interest to be chosen in estimating the earning power of the credits in the reserve funds. A strict theory of the earning power of the renewal fund would take into consideration not only the method of investing the fund, for example, whether it be used in making extensions and betterments in the System, or invested in separate securities and treated like a trust fund, but also the rate of annual interest which should be adjusted each year in accordance with the actual value of the money.

At October 31st, 1921, the total depreciable capital was the whole of the capital investment, namely about $6,000, while no reserve for renewals had yet been established at that date. At September 30th, 1922, the depreciable capital was about $33,000, and if the proposed extensions be carried out will be about $96,000 at October 31st, 1923, unless the Province assumes part of the costs of the rural lines, which would correspondingly reduce the depreciable capital.

Sinking Fund.

The study of the finances of the System shows that $88.62 has been set aside as sinking fund to provide for the financial obligations concerning the properties. No sinking fund reserve has yet been made in respect of rural lines, which it is expected will comprise the greatest portion of the capital expenditures as long as no power is generated on the Ottawa System by the

[illegible] [illegible] [illegible] [

Commission. The first rural line expenditure was made in 1921, so that the collection of the sinking fund reserve chargeable against rural lines can be commenced only in 1926 or 1927.

Reserve for Contingencies.

Up to the end of 1921 no reserve for contingencies had been established.

Having in mind the contemplated extended construction of rural lines and the heavy losses which might be occasioned to them through catastrophe, it is felt that a suitable rate per horse-power consumed should be charged to rural customers or some other means found so that a sufficient fund might be available to be drawn on in case of emergencies. When a fund of about $5,000 will have been built up, the rates can be readjusted to suit the conditions found after several further years of experience.

Discussion of Deficits and Surpluses.

The records show that the System as a whole has been billed with the cost of power in accordance with the book-keeping methods of the Hydro-Electric Power Commission since 1907, and that there are now no deficits nor surpluses for the System as a whole. This does not take into account the local distribution in the City of Ottawa which is done by a separate Commission in that city, and where the profits or losses are not included in the accounts of the Hydro-Electric Power Commission for the Ottawa System.

Destination. The first rural line expenditure was made in 1923, so that the existence of the sinking fund reserve chargeable against rural lines can be commenced only in 1926 or 1927.

Density of Population.

It is the end of 1921 we receive the questionnaire you have enclosed.

Having in mind the contemplated extended construction of rural lines and the fixed income which has accrued to them [illegible] it is felt that a minimum rate per thousand assessed should be charged on rural assessment to pay other rates. [illegible] a satisfactory [illegible] which is well-nigh to be done on in view of assessment. [illegible] a [illegible] of [illegible] will have been built up, the rates can be established by [illegible] the conditions [illegible] after several further years of experience.

Adequacy of Capital and Revenue.

The result also that the system is [illegible] has been filled with the [illegible] of power in accordance with the [illegible] methods of the Ontario-Hydro. Power Commission plans [illegible], and that there are now [illegible] the system as a whole. This does not take [illegible] the local [illegible] within [illegible] of [illegible] which is [illegible] [illegible] [illegible] [illegible] [illegible] of the Ontario-Hydro Power Commission for the [illegible] system.

Revenues and Costs per Horse-power per Annum.

In order to reduce the total revenues and total costs of operation to a basis where these would be comparable with other systems, and to agree with the usual practice of other companies and of distribution authorities, a table of figures has been prepared to show the revenue per horse-power per annum for different bases of horse-power.

In a similar way the total costs have been reduced to costs per horse-power per annum for different bases of horse-power, and have also been analyzed to show the total annual costs subdivided into fractional amounts chargeable against each kind of expense based on the amount of horse-power purchased. Because of the fact that the amounts of horse-power purchased and horse-power billed are the same, only one table and diagram of subdivided costs have been included herein.

The following series of diagrams with the tables of figures for each show the various items in detail.

Revenues per Horse-power per Annum.

The revenues for each of the various classifications of horse-power are given in the following table:

Table of Revenues per Horse-power per Annum

	Fiscal Years Ending October 31st,			
	1918	1919	1920	1921
Purchased and Billed	$14.11	$14.10	$14.14	$13.60
Average Twelve Monthly Peaks	14.19	14.34	14.06	13.79
Maximum Yearly Peak	12.76	12.34	12.52	11.44

Annual Costs per Horse-power.

The following tables and the two sheets of curves included as pages 42 and 43 show the details of the costs per horse-power per annum on different bases. The figures from which these curves were plotted are the figures for the operating costs given in the table on page 34 divided by the figures for the various classes of horse-power already given in the text. The table below and the sheet of curves included as page 42 indicate the total costs per horse-power per annum for the different classifications of horse-power already discussed. It will be noted that the total costs per horse-power per annum balance with the total revenues per horse-power for the whole term of years for which revenues and costs are available.

The sheet of curves on page 43 entitled "Subdivided Costs per Horse-power Purchased and Billed" indicates the subdivision of the total annual costs as between power purchased and billed, overhead and general expense, interest and sinking fund, divided by the total amounts of horse-power purchased by the Commission and sold to the City of Ottawa.

Table of Total Costs per Horse-power per Annum

	Fiscal Years Ending October 31st,			
	1918	1919	1920	1921
Purchased and Billed	$14.11	$14.10	$14.14	$13.60
Average Twelve Monthly Peaks	14.19	14.34	14.06	13.79
Maximum Yearly Peak	12.76	12.34	12.52	11.44

Table of Subdivided Costs per Horse-power Purchased and Billed

	Fiscal Years Ending October 31st, 1918	1919	1920	1921
Power Purchased	$14.00	$14.00	$14.00	$13.50
Overhead and General Expense	.11	.09	.13	.09
Interest and Sinking Fund	-	.01	.01	.01
Totals	$14.11	$14.10	$14.14	$13.60

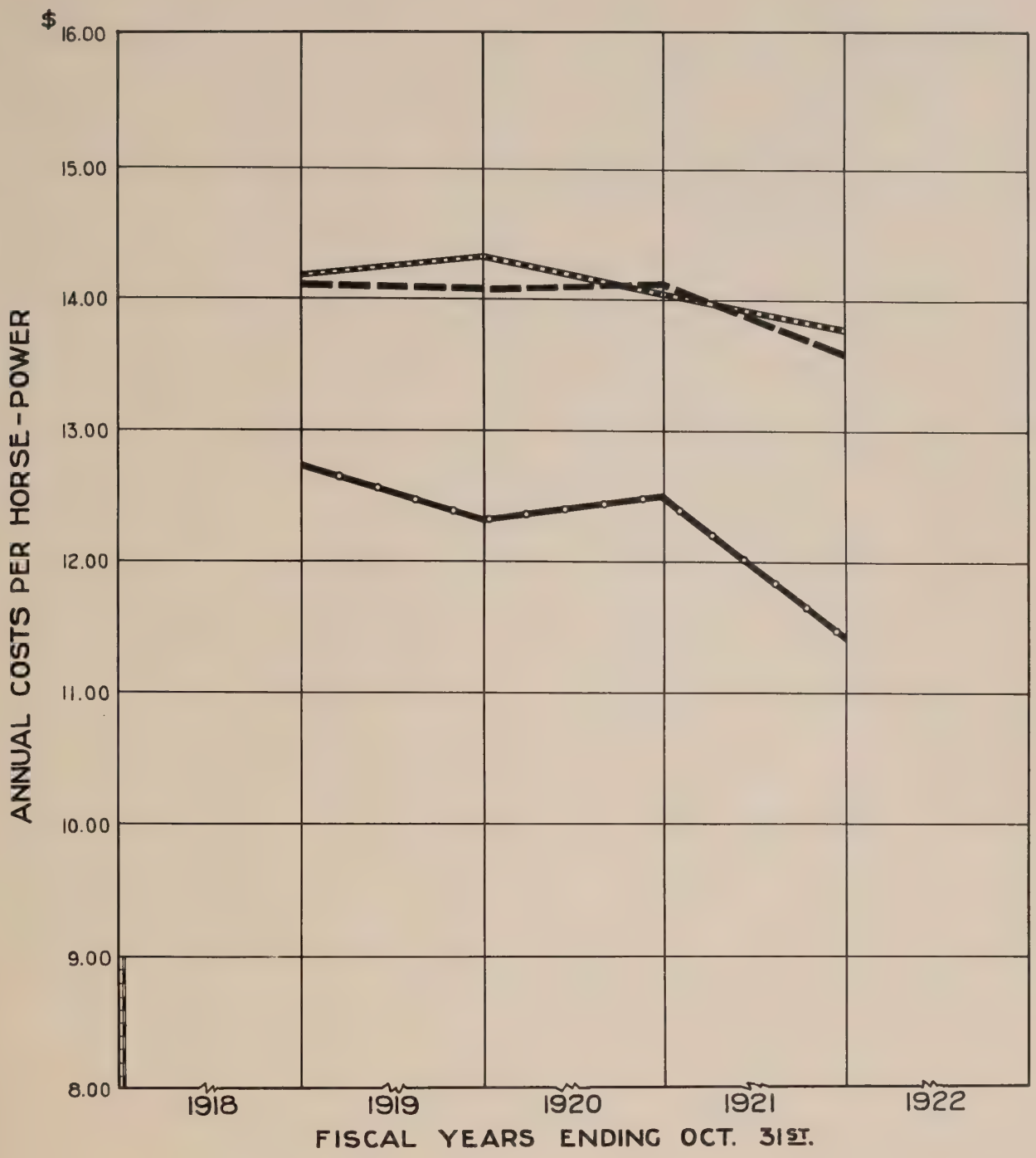
Kilowatt-hour Data.

The engineers of the Hydro-Electric Power Commission state that there is no record available of the total kilowatt-hours supplied to the Ottawa System.

The following table shows the kilowatt-hours per consumer for domestic use and for commercial lighting, and also shows the number of horse-power per power consumer served by the Corporation of the City of Ottawa during the years 1914 to 1921 inclusive. The diagrams included as page 44 show this data in graphic form.

Table of Various Classes of Power Consumption
by the Corporation of the City of Ottawa

	Fiscal Years Ending October 31st, 1914	1915	1916	1917	1918	1919	1920	1921
K.W.H. per Domestic Consumer	217	241	269	275	368	538	631	810
K.W.H. per Commercial Light Consumer	1,245	1,416	1,615	1,757	1,995	2,670	2,548	2,723
Horse-power per Power Consumer	-	-	-	17.4	22.9	21.5	21.6	20.6



H. P., AVERAGE OF 12 MONTHLY PEAKS
H. P. PURCHASED AND BILLED
H. P., MAXIMUM YEARLY PEAK

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

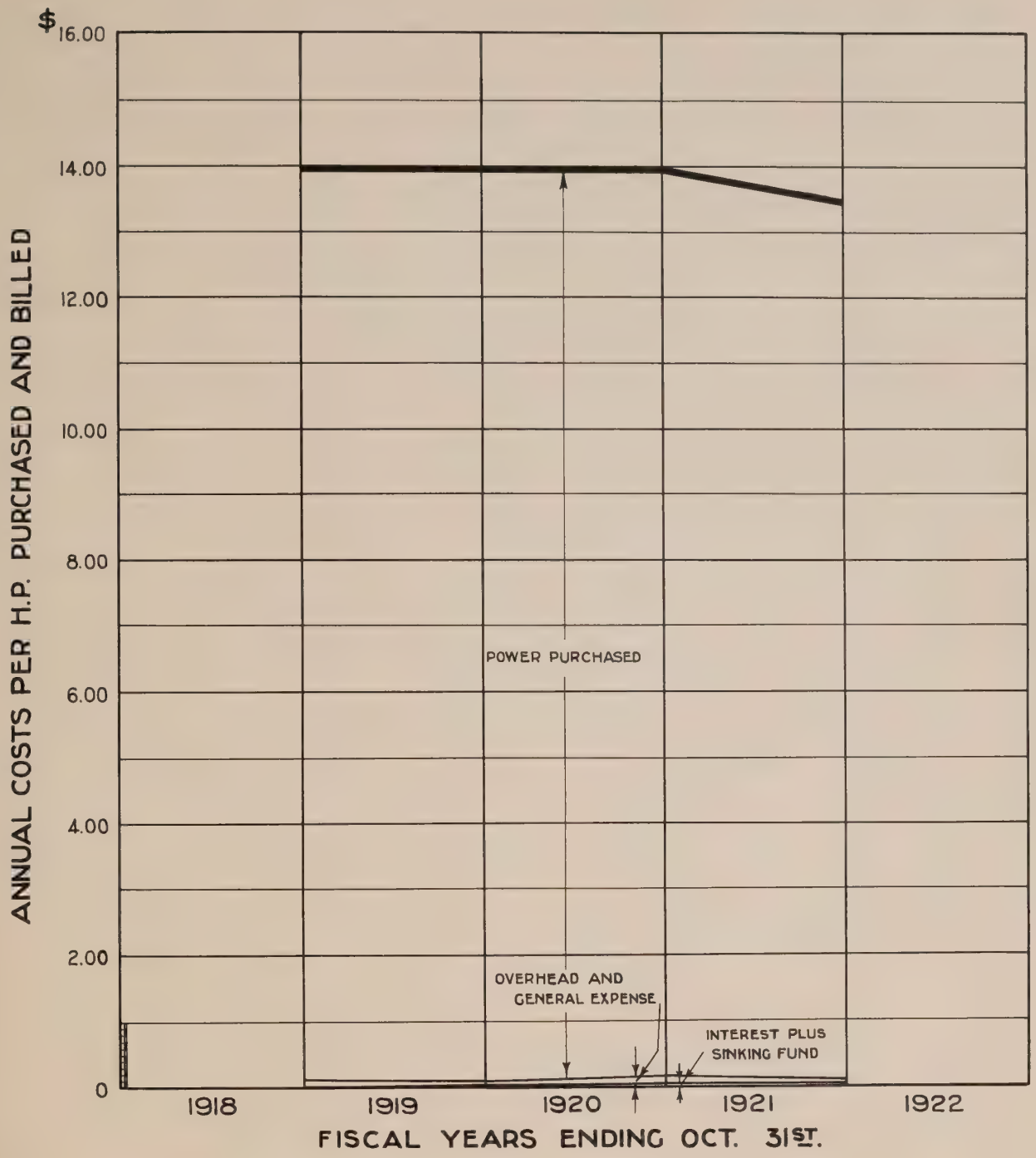
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

OTTAWA SYSTEM

COSTS PER H.P. PER ANNUM
VARIOUS H. P. BASES

Toronto, April 20th, 1923. Made by [illegible] Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

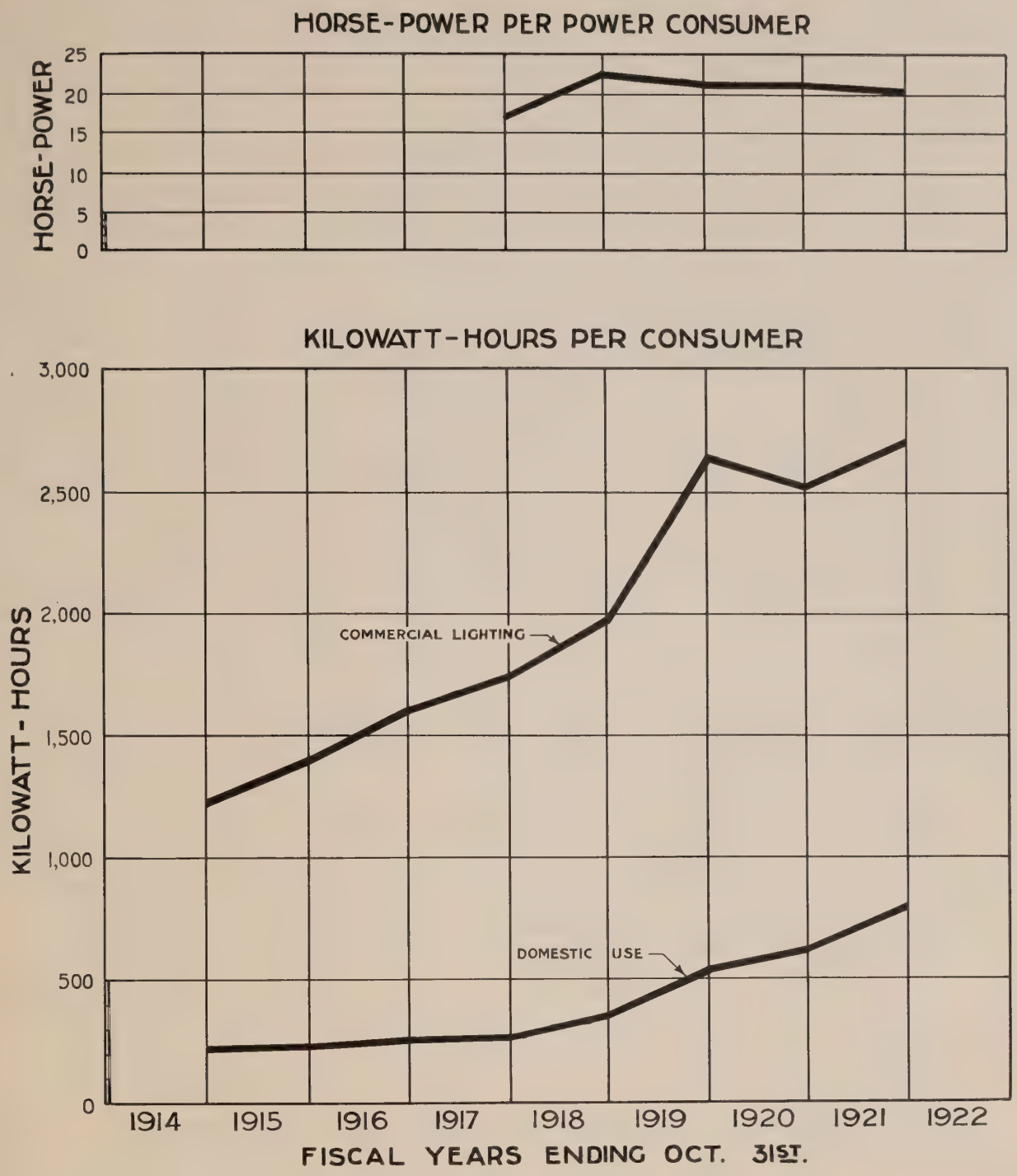
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

OTTAWA SYSTEM

SUBDIVIDED COSTS PER ANNUM PER H.P. PURCHASED

Toronto, April 20th., 1923 Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS



HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

OTTAWA SYSTEM

KILOWATT-HOUR DATA
AND H.P. PER POWER CONSUMER

Toronto, April 20th., 1923. Made by [illegible], Checked by [illegible]

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Summary.

A summary of a number of the more salient points which have been studied and discussed in the foregoing report may be of advantage in continuing the consideration of the economics of the Ottawa System. They are as follows:

(1) The capital costs of the Ottawa System are very small. At October 31st, 1921, the only properties owned by the Commission were meters installed in one of the generating stations of the Ottawa & Hull Power & Manufacturing Company.

(2) Capital costs projected for 1922 and 1923 amounting to about $90,000 would make the total investment in the Ottawa System approximately $96,000 at October 31st, 1923. The whole of this amount for extensions is for completion and addition to the rural lines now under construction.

(3) To facilitate future economic studies and to assist in operating efficiency it would be well to keep accurate records of kilowatt-hours used at each principal consuming point on the System.

(4) The market for power is divided in the district between the Hydro-Electric Power Commission and other interests. The total population served by all at the present time is about ninety per cent. of that of the district. The use of electricity per ordinary consumer is apparently greater in this district than in many others. The continual growth in load indicates that the demands are growing, and it is likely that a considerable increase in the power demand can take place in the district.

The ultimate demand of the Ottawa System and district can be taken care of by the development of local power sites, the capacity of which amounts to one million horse-power or more.

Power transmitted from the sites in the vicinity of Ottawa can be readily a solution of the problem of source of power to supply the ultimate demands of the Rideau and St. Lawrence Systems. Interconnecting lines between the three systems would make this feasible without the necessity of expenditures for very much additional equipment, as the transforming and distributing stations of the Rideau and St. Lawrence Systems are both designed to operate at 44,000 volts. The frequency of the power generated by all the important plants in the Ottawa district is 60 cycles, similar to that of the power used in the three above mentioned systems.

(5) A reserve for renewals should be established after carefully considering the estimated useful life of the meters and rural lines now being constructed in the System, and also adjusted to allow for the actual cost of money year by year.

(6) The question of sinking fund should be considered in relation to the term of years in which a fund is to be built up, that will be sufficient to provide for the proportionate amount of capital costs chargeable against the Corporation of the Township of Nepean. The agreement with the Commission specifies a term of twenty years, whereas that section of the Power Commission Act which pertains thereto specifies a thirty-year term at the end of which the proportion of the capital costs chargeable against the Township are to be paid off.

(7) No reserve for contingencies has as yet been established. It was suggested in this report that a charge per horse-power delivered to the rural customers should be included in the cost of power and yearly results noted, so that when a fund will have been built up ample to provide for damage to the rural lines due to catastrophe and accidents, a proper yearly allowance for the fund might eventually be devised.

(8) The operating records indicate that the System as a whole is being operated so as to supply power at cost, there being no difference between the total revenues and the total costs as shown on the Commission's books.

Walter J. Francis

Consulting Engineer.

Toronto, April 20th, 1923.

Toronto, April 20th, 1944.